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EFFECTS OF PLANTER VIBRATION ON BALANCE AND POSTURAL INSTABLITY IN CHRONIC STROKE PATIENTS

Yaser Majeed[1], Hafsah Arshad[*2], Hafsah Gul Khattak[3], Abdul Moiz Khan[4], Fiza Farooq Abbasi[5], Kinza Anwar[6], Etisam Wahid[7]

[1]Senior Lecturer Helping Hand Institute of Health Sciences
*[*2]Assistant Professor Ibadat International University Islamabad*
[3]Senior Lecturer Ibadat International University Islamabad
[4]Consultant physiotherapist Physiomax and physio first Rehabilitation center
[5]Lecturer Hazara University, Mansehra
[6]Senior Lecturer Riphah International University, Islamabad
[7]Lecturer FAHS, Gomal University, DI khan

[*2]hafsah.arshad@uipt.iiui,edu.pk, [3]hafsahgull_khattak@yahoo.com, [4]fizzaabbasi000@gmail.com, [5]kinza.anwar@riphah.edu.pk, [6]etisamwahid35@gmail.com

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ABSTRACT

To determine the effect of planter vibration on balance and postural control in chronic stroke patients. The randomized controlled trial (RCT) was conducted from June 2021 to September 2021. Thirty-six patients were divided into two groups on the basis of toss and coin method. The inclusion criteria were both gender of age between 40 years to 70 years, participants who had their first ever stroke ≥ 6 months ago, medically stable, able to walk without use of walking aids, Rankin Modified Scale 4 score and able to understand verbal commands. Participations in other treatment protocols for balance, presence of other neurological or musculoskeletal conditions affecting balance, history of fracture or lower-limb surgery within the 12 months, having vestibular, visual or auditory disorders were excluded from study. The outcomes of study were berg balance scale, the Modified of the Postural Assessment Scale for Stroke Patients (PASS) and Stroke Specific Quality of Life Scale (SS-QOL). Measurements were taken at baseline and after six weeks of intervention. Data was analyzed using SPSS 21.The overall mean ages was 63.62±7.31years. Of 32 participants, 21 (66%) male and 11 (34%) female participants completed the study. Experimental group showed significantly better results for BBS, SS-QOL and M-PASS values (p< 0.05 each). Planter vibration training along with conventional physiotherapy treatment had better outcome as compared to only conventional physiotherapy treatment on balance, postural control and quality life of in chronic stroke patients.

Keywords: *BBS, Balance, chronic stroke patients, planter vibration, SS-QOL, PASS*

INTRODUCTION

The World Health Organization defined stroke as rapidly developing clinical signs of focal or sometimes global disruption of brain function occurring for over more than 24 hours or leading to death with no clear cause other than a vascular origin. It is reported that stroke is the 2nd leading

cause of death and disability globally, and accounts for 5.5 million deaths per year. The burden of stroke is not limited to its high mortality rate but its high morbidity leaves 50% of survivors with long term disability. Hence, stroke is a disease of major social and economic concerns and is extremely important for public health (1). It is observed that South Asia is key contributor to global stroke burden with significant variations across the region. Compared to other parts of the world, South Asia is different in terms of higher prevalence of stroke, onset at younger age, higher death rate, and several under-studied risk factors of stroke (2). There is limited literature on prevalence and incidence of stroke in Pakistan. The incidence of stroke reported in Pakistan is 250/100,00 per year (3). A small scale cross sectional study conducted in Karachi reported stroke prevalence in adult Pashtun community to be 4.8%. The majority cases (30%) of stroke were reported at 45 years of age or younger and also reported that stroke prevalence was equal in both gender (4). Integrated population health survey in Khyber Pakhtunkhwa (KP) province of Pakistan reported 1.2% prevalence of stroke. The common associated rick factors were high blood pressure, diabetes, obesity, smoking, physical inactivity, coronary heart disease (5-8).

Stroke patients are less able to adjust perturbation on affected side, put less weight shifts on affected lower extremity which results in more severe postural stability issues. Moreover, post-stroke balance problems and fear of falling lead to decrease in step length and walking speed. The reason of high rate of fall in stroke patients is due to loss of balance and postural control during rehabilitation session and in everyday life as well. Thus, it is important to develop balance and postural control in such patients to avoid incidence of fall (9). Stroke patients typically exhibit decreased cutaneous sensation and sensory impairments. Poor balance in stroke patients may be attributed to sensory impairment and muscle weakness, following a stroke attack. Recent literature has shown that balance difficulties in stroke patients are caused by impaired planter cutaneous sensation. The sensory impairments in stroke patients is due to damage to somatosensory cortex that leads to inefficient interpretation of sensory feedback. These sensory impairments may worsen the functional outcome in stroke patient and also lead to poor balance (10). The planter surface of foot serves as sensory area for balance, modification of foot position, and postural control. Particularly quickly adapting vibration-sensitive cutaneous receptors are randomly distributed over the planter surface and are more in comparison to slowly adapting receptors (11). Vibration stimulation is a useful technique to improve balance in both healthy individuals and patients with poor balance. There are four type of mechanical receptors, each have unique characteristics and transmit the mechanical aspect of touch from environment in a way that is more efficient, are used in vibration therapy to improve the neuromuscular responses that maintain body posture (12). A recent study conducted in Iran, examined the effects of plantar vibration (100Hz for 5 minutes) on balance in 22 stroke patients using the clinical Mini-Balance Evaluation Systems Test (Mini-BESTest). The study found improvements in ankle dorsiflexion passive range of motion (PROM), balance, and plantar flexor spasticity (13). The objective of present was to investigate effects of plantar vibration on balance and postural stability in chronic stroke patients.

Methodology:

This single blinded randomized control trial was conducted at Department of Physical Therapy and Rehabilitation, Pakistan Railway Hospital, Rawalpindi. The study was conducted from June 2021 to September 2021 after approved by the ethical committee of Riphah College of Rehabilitation Sciences (Reference number RIPHAH/RCRS/REC/letter-00392). The clinical trial was registered prospectively (IRCT registration number: **IRCT20210830052336N1).**

The participants were randomly divided into 2 groups (control group A and experimental group B) by coin toss method using convenient sampling technique. The inclusion criteria were both gender of age between 40 years to 70 years, participants who had their first ever stroke ≥ 6 months ago. Those who are medically stable, able to walk without use of walking aids, Rankin Modified Scale 4 score and able to understand verbal commands. Participations in other treatment protocols for balance, presence of other neurological or musculoskeletal conditions affecting balance, history of fracture or lower-limb

surgery within the 12 months, having vestibular, visual or auditory disorders were excluded from study. Furthermore, presence of abnormal synergies, fixed ankle contractures, uncontrolled diabetes or hypertension, use of medication that may affect balance were also excluded. Participants were informed about the study protocol, possible risk factors and written informed consent was also taken before enrollment in study. The sample size of the study was calculated using an open epi-tool, with 95% confidence level. The sample size was 36 and participants were randomly divided into two groups, 18 participants in each group.

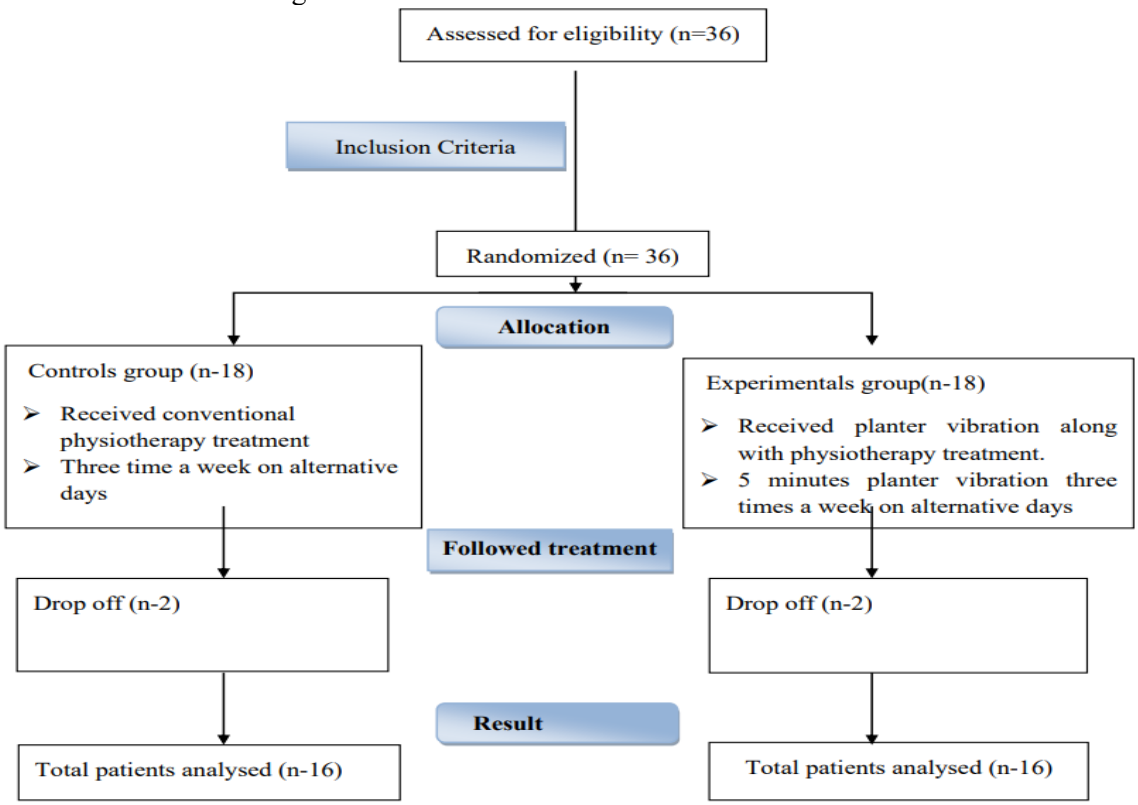
The primary outcome of study was berg balance scale. The secondary outcomes of measure were: The Modified of the Postural Assessment Scale for Stroke Patients (PASS) and Stroke Specific Quality of Life Scale (SS-QOL). Measurements were taken at baseline and after six weeks of intervention. The participants of control group received conventional strengthening exercises, stretching exercises, gait training and balancing exercises whereas, participants in experimental group received conventional physiotherapy treatment stretching exercise of tight muscles (hamstring and calf muscle), strengthening exercise of weak muscles, sitting and standing balance exercise along with planter vibration for 5 minutes, frequency 20-40Hz on alternative days 3 times per week for 6 weeks. A planter vibratory device (OTO electro reflexologist ER 839S) was used to give vibration, during the intervention participants were positioned in sitting position, ask to sit on chair with leg flexed and put the most affect foot on vibratory device. Total 30-minute session was given to participants.

Statistical analysis was done by using SPSS 21.0. Demographic and baseline data were given as mean and standard deviation for both intervention groups. Normality of data was analyzed using Shapiro-Wilk value. The data was normally distributed with p value of all variables >0.05 therefore parametric test (Independent Samples T-Test and Paired Samples T-Test) were used for analysis.

Results:

Total numbers of participants were 36, which were equally divided into two groups: control group(n=18) and experimental group(n=18). There were 4 drop outs from the study. Details of participants analyzed is given in figure 1.

Figure 1: CONSORT flow diagram



The final analysis included 32 participants. 21 (66%) male and 11 (34%) female participants completed the study. The overall mean ages was 63.62±7.31years. The mean age for control group was 63.37± 7.94 years and 63.87±6.87years was for experimental group. 8 participants presented with right side hemiplegia and 24 participants were with left side hemiplegia. Regarding type of stroke 29 were with ischemic and 3 were with hemorrhagic stroke. The overall mean value for duration of stroke onset was 12.09±2.61, whereas for control group was 13±2.30 months and for experimental group was 11±32.87 months. The mean body mass index (BMI) for control and experimental group was 29.15±2.49 and 27.35±3.00. 29 participants presented with ischemic and 3 participants were with hemorrhagic type of stroke. Majority of participants (n=24) presented with left side hemiplegia and remaining 8 participants had right side affected.

Within group analysis showed significant improvement (p value <0.05) in both control and experimental groups for BBS, SS-QOL and MPASS. Detail given in table 1. Whereas, between group analysis showed better results in experimental group participants for BBS, SS-QOL and MPASS at post intervention assessment done (p value < 0.05) (Table 2).

Table 1: Within group analysis (Paired t test)

variable	Groups (n= 32)	Pre-intervention Mean ± SD	Post-intervention Mean ± SD	P value
BBS	Control (n=16)	30.62± 4.31	34.62 ± 2.18	0.06
	Experimental (n=16)	29.93± 5.00	39.62± 3.36	0.00
SS-QOL	Control (n=16)	137.65± 11.37	157.50 ± 11.35	0.05
	Experimental (n=16)	137.87± 12.83	168.31± 7.28	0.00
MPASS	Control (n=16)	21.25± 4.58	25.62± 1.89	0.04

	Experimental (n=16)	21.68± 4.42	28.75± 2.54	0.05

Table 2: Between group analysis (Independent t test)

Variable		Control group (n=16)	Experimental group (n=16)	p- value
BBS	Baseline	30.62± 4.31	29.93± 5.00	0.68
	Post-intervention	34.62 ± 2.18	39.62± 3.36	0.05
SS-QOL	Baseline	137.65± 11.37	137.87± 12.83	0.94
	Post-intervention	157.50 ± 11.35	168.31± 7.28	0.003
MPASS	Baseline	21.25± 4.58	21.68± 4.42	0.72
	Post-intervention	25.62± 1.89	28.75± 2.54	0.04

Discussion:

Balance disorders are common cause of disability in stroke patients. Vibration stimulation is noninvasive physiotherapy modality used to improve balance and functional outcomes in healthy individuals and patients as well. The results of our study has also shown that planter vibration in stroke patients has improved balance and postural stability. Literature also supports that mechanoreceptors in the sole of foot play pivotal role in postural control and gait, and vibration stimulation increase the mechano receptor stimulation (14).

A randomized control trail by Maede Khalifeloo et al reported that planter vibration with 100 Hz frequency for 5 minutes improved dynamic balance and functional mobility in stroke patients. The study was done 18 post stroke patients with mean age of 56.0±8.9 years. Significant improvements were seen in Time up and go test ($p=0.03$), ankle PROM ($p<0.01$) and muscle spasticity at ankle ($p=0.08$). The study also suggested that there was no change on static balance and Functional Reach test (15). Se-Won Lee et al conducted a RCT on effect of a local vibration stimulus training program on postural sway and gait in chronic stroke patients. Along with a standard rehabilitation program, local vibration stimulus training program group was given 30 minutes a day, five times a week, for 6 weeks. The finding suggested that local vibration treatment was effective in improving gait parameters like speed, steps per minute, step length and posture in chronic stroke patients. (16). A systemic review by Jonas Schroder et al found that peripheral somatosensory stimulation (PSS) improved postural stability after stroke and was effective if immediately used as adjuvant to exercises in long term therapy. The peripheral somatosensory stimulation can promote postural recovery following stroke by enhancing afferent input by affected leg (17). Andriana Teresa Silva conducted a study to investigate effects of vibration therapy on motor function and planter impression in 28 stroke patients. Vibration therapy was given for thrice weekly and for 8 weeks. They found no statistical significant difference within and between group analysis in plantar impression on affected side. Moreover, 6-minute walk test showed statistically significant result ($p=0.03$) within group (18).

Sung Il Hwang and his colleagues randomized 20 stroke patients to control group and vibration group. The control participants performed conventional exercise whereas experimental group received whole body vibration for ten minutes. There was significant difference for berg balance test between both groups. They reported that 4 week of whole body vibration intervention improve balance and functional mobility in sub-acute stroke patients (19). Marco Paoloni et al reported that when segmental vibration was applied to ankle muscles in experimental group for 12 sessions in four weeks, showed favorable results in gait parameters and walk. Significant improvements were seen in swing velocity, walking speed, stride length, dorsiflexion at ankle during heel strike and planter flexion of ankle during swing phase also shown improvement. They concluded that positive effects of vibration may be the result of corticomotor excitability and reorganization at brain level. Additional benefits of mechanical vibration is that it also improves foot drop in chronic stroke patients (20).

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